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Characterization Plan for Diesel Contamination in TRA Perched Water Well PW-13

Tom Wood

February 2004

Idaho Completion Project

Bechtel BWXT Idaho, LLC

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Idaho Falls, Idaho 83415

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ABSTRACT

This Characterization Plan for the Test Reactor Area well PW-13 has been developed to determine causes for the continued recurrence of diesel in the perched water. The information and data obtained in the completion of these activities will also assist in the determination of potential environmental or human health impact related to its continued presence.

Well PW-13 was drilled and cored in 1990 to characterize contaminant occurrence and distribution in perched water bodies that had formed beneath the Test Reactor Area wastewater infiltration ponds. During coring operations free-phase diesel was found in the corehole. Approximately 20 gal of diesel were removed from the corehole over the next 2 months by bailing. Prior to completion of the well and during well development in January 1991, no diesel was detected. A 1.03 ft-thick layer was measured in the well in 1999. The volume of diesel in the well decreased to nondetectable levels and subsequently returned at least twice since 1999.

Investigations after discovery of the diesel suggest that the diesel was the result of a 2,000-gal leak from a nearby fuel line that occurred in 1981. A Track 2 Investigation of PW-13 was completed in 1994, and PW-13 received a "No Further Action" determination. A 2001 Track 1 Investigation of TRA-57, the fuel line believed to be the diesel source, completed a GWSCREEN model. The modeling was conducted to determine the risk due to ingestion of aquifer water. The risk determination was based upon all 2,000 gal of diesel migrating into the aquifer. The calculated volume of the diesel (2,000 gal) in the subsurface did not pose a risk to human health and the environment.

Although it is still believed that the diesel does not pose a significant threat to the aquifer, the fact that the diesel has not dissipated as expected needs further investigation. Several mechanisms are proposed here that might cause the intermittent occurrence of diesel in PW-13.

This Characterization Plan describes the proposed activities to be conducted at the Test Reactor Area to characterize the nature and extent of contamination. The activities will evaluate the extent of diesel contamination. Sampling efforts will collect data to evaluate the current chemistry of the perched water and perched water sources. The data will be used to evaluate the flow paths and conditions in the subsurface, as well as the extent of diesel contamination in the perched water. Two perched water wells will be installed to further evaluate the nature and extent of contamination and potentially provide information as to the mechanism controlling the diesel recurrence.

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FIGURES

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ACRONYMS

bls	below land surface
CFR	Code of Federal Regulations
CWP	Cold Waste Pond
DRO	diesel range organics
ETR	Engineering Test Reactor
FSP	Field Sampling Plan
GRO	gasoline range organics
HASP	Health and Safety Plan
INEEL	Idaho National Engineering and Environmental Laboratory
msl	mean sea level
MTR	Materials Test Reactor
TRA	Test Reactor Area
USC	United States Code
USGS	United States Geologic Survey
WWP	Warm Waste Pond

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1. INTRODUCTION

The Test Reactor Area (TRA) is located in the south-central part of the Idaho National Engineering and Environmental Laboratory (INEEL). The TRA, built in the 1950s, has served to house high-neutron flux nuclear reactors and to test the effect of radiation on materials, fuels, and equipment (see Figure 1). Three nuclear reactors are located at the TRA; currently, only the Advanced Test Reactor (ATR) is operational. The Materials Test Reactor (MTR) and the Engineering Test Reactor (ETR) are no longer in service.

Wastewater generated from TRA activities has been disposed to unlined ponds since the early 1950s. These ponds consisted of the Warm Waste Ponds (WWP) (1952–1993), Cold Waste Ponds (CWP) (1982–present), Chemical Waste Pond (1962–1999), and Sanitary Waste Ponds (1952-present). The CWP presently is the principal site for wastewater disposal at the TRA. Infiltration of wastewater has resulted in the formation of shallow and deep perched groundwater bodies in the thick vadose zone at the TRA.

Well PW-13 monitors deep perched groundwater at the TRA. This well is located within the Test Reactor Area in the south-central part of the Idaho National Engineering and Environmental Laboratory (INEEL). The well was installed in 1990 approximately 50 ft southwest of the Materials Test Reactor (MTR) on the south end of Pike Street (Figures 1 and 9). During coring operations, a layer of free-phase diesel was discovered at the water surface. This layer of floating diesel was removed prior to well completion. The contamination at PW-13 was first investigated in a Track 2 Investigation in 1994 (Sherwood et al. 1994). TRA-57, the diesel transfer line believed to be the source of the diesel, was investigated in a Track 1 Investigation in 2001 (INEEL 2002). The PW-13 Track 2 received a "No Further Action" determination, and the Track 1 for TRA-57 recommended continued monitoring of PW-13.

Since the first reoccurrence in 1999, a floating layer of diesel has been observed in PW-13 at least twice. The first reoccurrence was in November 2000, the second in June 2001. After each occurrence, the diesel layer subsequently disappeared from the well without remediation. Recurrence and mobility of this contaminant indicates that further characterization is required.

1.1 Purpose and Scope of Work

This Characterization Plan has been prepared in response to the continued recurrence of diesel in the Test Reactor Area (TRA) perched water monitoring well PW-13 as noted in the *First Five-Year Review Report for the Test Reactor Area, Operable Unit 2-13, at the Idaho National Engineering and Environmental Laboratory* (DOE-ID 2003a). The activities in this work plan constitute the first field scale investigation of the diesel contamination.

This investigation of PW-13 will include a review of the history of the contamination, groundwater sampling activities, and the drilling and installation of two perched water wells. This investigation will evaluate the extent of the diesel contamination and potentially provide information as to the mechanism controlling the continued recurrence of diesel in PW-13. Groundwater sampling data will be used to evaluate the recharge source for various perched water wells, and to define the flow paths from each source. Groundwater samples also will be collected for analyses to evaluate the potential for migration of dissolved diesel constituents in the perched water at TRA, and to determine whether any of these constituents have migrated into aquifer wells.

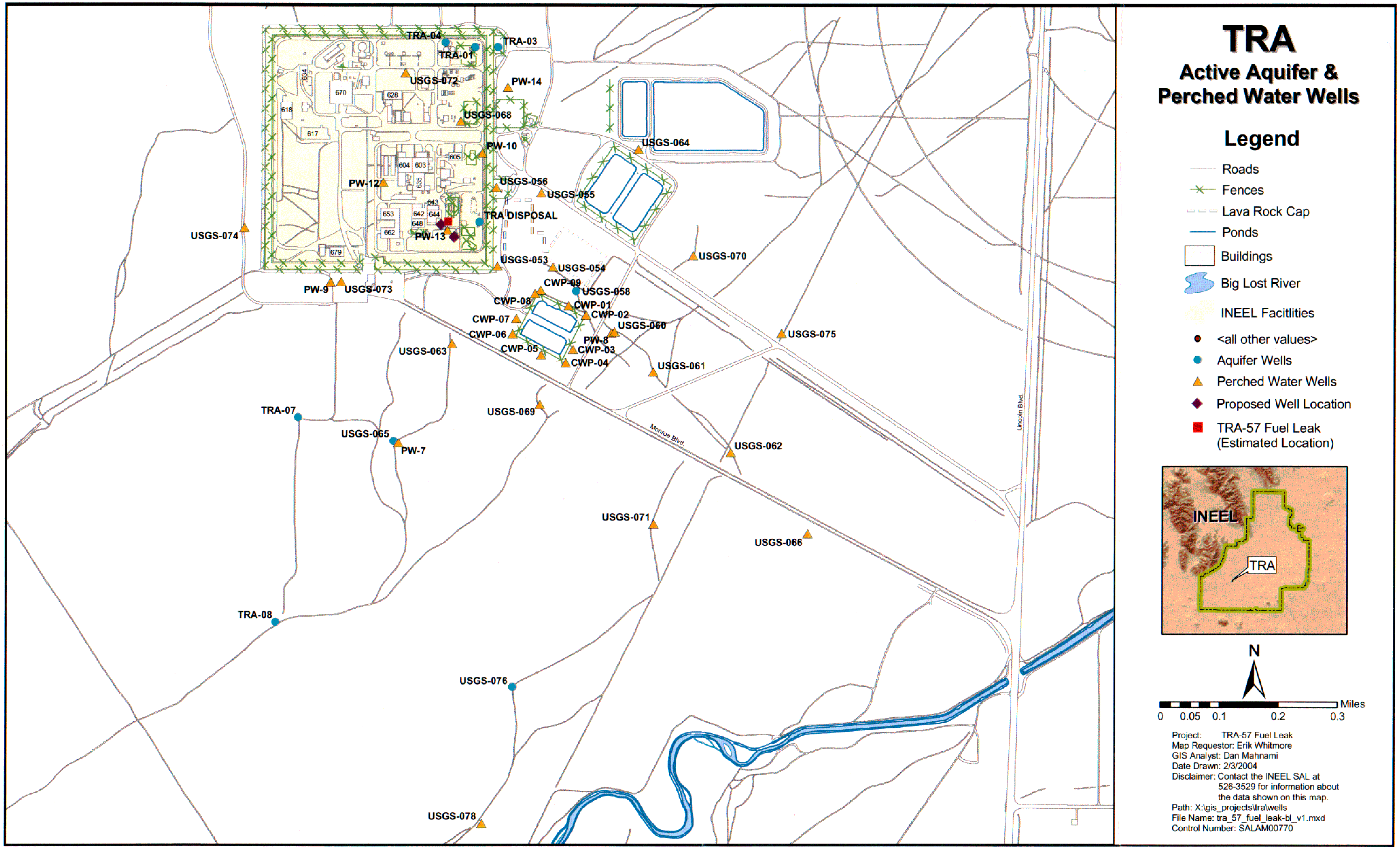

Figure 1. Map of the Test Reactor Area and surrounding wells.

2. OVERVIEW

Perched groundwater bodies have formed in the vadose zone beneath the TRA since the early 1950s in response to infiltration of wastewater disposal to unlined TRA ponds. Formation of perched groundwater at TRA is controlled by permeability contrasts in the basalt/sediment sequence that comprises the vadose zone. Subsequent sections describe the hydrogeologic framework, groundwater perching mechanisms, and construction and contaminant history of monitoring well PW-13.

2.1 Hydrogeologic Framework

The TRA is located on an alluvial plain that consists of surficial sediment with thickness ranging from 30 to 75 ft. A series of basalt flows interbedded with sedimentary deposits of eolian and fluvial origin underlie the surficial sediments. The sedimentary interbeds vary in both thickness and lateral extent. The basalt contacts, often rubbly and highly vesicular, are usually very permeable, water-bearing intervals in both the perched water zones and the aquifer. The basalt/sediment interfaces have much lower permeabilities and act as aquitards and perching layers.

Basalt flows in the vadose zone and upper part of the aquifer underlying the TRA range from about 20 to 130 ft thick. Contacts between these flows are rubbly, fractured, and very vesicular. These interflow zones typically are capable of rapidly transmitting water horizontally in the thick vadose zone and the aquifer. Basalt flow interiors are massive and less fractured. These flow interiors are less capable of transmitting water. The sedimentary interbeds vary in thickness and lateral extent beneath the TRA. The capacity of these sand, silt, and clay units to transmit water is much less than that of basalt interflow zones and fractures. The complex configuration of interconnected interflow zones and sedimentary interbeds in the vadose zone beneath the TRA provides the hydrologic framework for formation of perched water bodies and groundwater flow beneath TRA wastewater disposal ponds

2.2 Formation of Perched Water Bodies in the Vadose Zone at TRA

Water from the TRA unlined ponds has been identified as the source of infiltrating water to the vadose zone beneath the TRA. Historically the CWP has been the largest source of water to the perched water zones; this pond has received an average of about 380 gpm of water since 1991. Recent discharge has averaged about 480 gpm for the past year. Annual average discharge to the ponds has been approximately 228 million gallons since 1982 with a peak discharge of 318 million in 1989. Perched water bodies have formed in the vadose zone due to the flux of infiltrating water from the unlined ponds and low permeability areas in the subsurface. When the flux exceeds the capacity of a low-permeability layer to transmit water, saturated conditions occur, creating perched water zones. Water spreads laterally following the slope of the low permeability areas. The size or "footprint" of the perched water zone expands until sufficient area is wetted to transmit the flux of infiltrating water. Widespread layers with very low permeability will form larger perched water zones. The footprint and depth of the perched water zone will increase or decrease as the rate of infiltration increases or decreases. The extent of the perched water beneath TRA has decreased in recent years. With the removal of the WWP, Chemical Waste Pond, and Sewage Leach Pond from service, the volume of infiltrating water has decreased. Until recently the average annual discharge to the CWP was also decreasing. The extent of the perched water body has decreased laterally and elevations have decreased. Elevations in 1991 ranged from 4,860 to 4,750 ft below land surface (bls), in 2003 elevations ranged from 4,850 to 4,730 ft bls. The apex of the deep perched zone is now centered beneath the CWP where it had previously extended to the northwest beneath the old WWP and TRA facility (DOE-ID 2003a).

Two zones containing perched water bodies have been formed beneath TRA created by discharge to the TRA ponds. The shallow perched water zone is formed within surficial alluvium. The perching mechanism is the contrasting permeability that occurs at the contact between alluvium and underlying basalt. The perched water zone is routinely monitored by seven wells. The variation in discharge to the CWP has caused most of the shallow perched water wells to show episodic wetting and drying.

The deep perched layer is found between 140 and 200 ft bls beneath TRA and consists of low permeability interbeds and dense basalt flow interiors. The deep perched zone has a greater areal extent than the shallow perched zone. This is attributed to a lower composite permeability of basalts and interbeds within the deep perched zone. The deep perched zone is routinely monitored in seven deep perched wells. PW-13 is screened within the deep perched zone, but has not been a routinely monitored well.

Water levels in perched water wells at TRA generally respond to changes in the discharge to the Cold Waste Pond (CWP). Water level changes in wells such as United States Geologic Survey (USGS) -53, USGS-54, USGS-60, and USGS-61 indicate attenuated response to changes in discharge volumes of the CWP (Figure 2). However, some wells, including PW-12 and PW-13, do not appear to directly respond to changes in the discharge of water to the CWP. PW-12 and PW-13 may have a secondary source, such as a leaking water pipe, or may be located along flow paths that dramatically attenuate their response. It should be noted that the flat lines portions of the USGS-53 and USGS-56 graphs indicate that the well was dry when measured. In Figure 2, the CWP discharge is displayed in a moving 7-month average. Data for a month were averaged with the 3 previous months and the 3 following months. The averaging process was repeated 3 times. The averaging smoothed the data, trimming the high signal while maintaining the low signal. Filtering the data in this manner allows the CWP data to be more readily compared to the attenuated response in the water levels of the wells.

2.3 History of Diesel Contamination at Well PW-13

Free-phase diesel was first detected in perched monitoring well PW-13 during its construction. Diesel later was detected in the well during routine monitoring operations. Subsequent sections describe the construction and completion of the well, contaminant history, and source term.

2.3.1 Well PW-13 Construction and Completion

Well PW-13 was drilled and cored in August and September 1990. Surface casing was set using a tricone bit to a depth of 42 ft. After a surface casing was grouted in place, coring was continued to total depth using an HQ coring system. Coring ceased at a depth of 145.2 ft bls on September 5, 1990. Coring resumed on September 6, 1990; when the first core of the day was retrieved, a diesel odor was noted. Coring was not continued after the diesel was noted. The coring had reached a total depth of 148.5 ft bls. After completion of coring, the corehole was bailed over the next 2 months until no free product could be recovered from the corehole. A history of the contamination at PW-13 is located in Section 2.3.2. The onsite geologist did not note any diesel odor or staining on any of the core at the time of coring. As part of this investigation, a review of the PW-13 core in December 2003 at the United States Geologic Survey also did not reveal any odor or staining.

The corehole was grouted from 148.5 to 95 ft bls on November 8, 1990. The hole was then over-reamed with a 9.875-in. drill bit from 42 to 97 ft bls. A bentonite seal was installed from 97 ft to 88.5 ft bls. The well is screened from 87.5 to 57.5 ft bls or 4,836.32 to 4,866.32 ft above mean sea level (msl), and has a filter pack of 10 × 12 silica sand from 88.5 (4,835.32 ft msl) to 52 ft bls (4,871.32 ft msl). A bentonite seal extends from 52 ft bls to the surface casing that was grouted in place at 42 ft bls. The well was developed on January 9, 1991. Fifteen gallons of water were bailed from the well; no diesel contamination was noted during well development. Figure 3 shows the well completion diagram and lithology of PW-13.

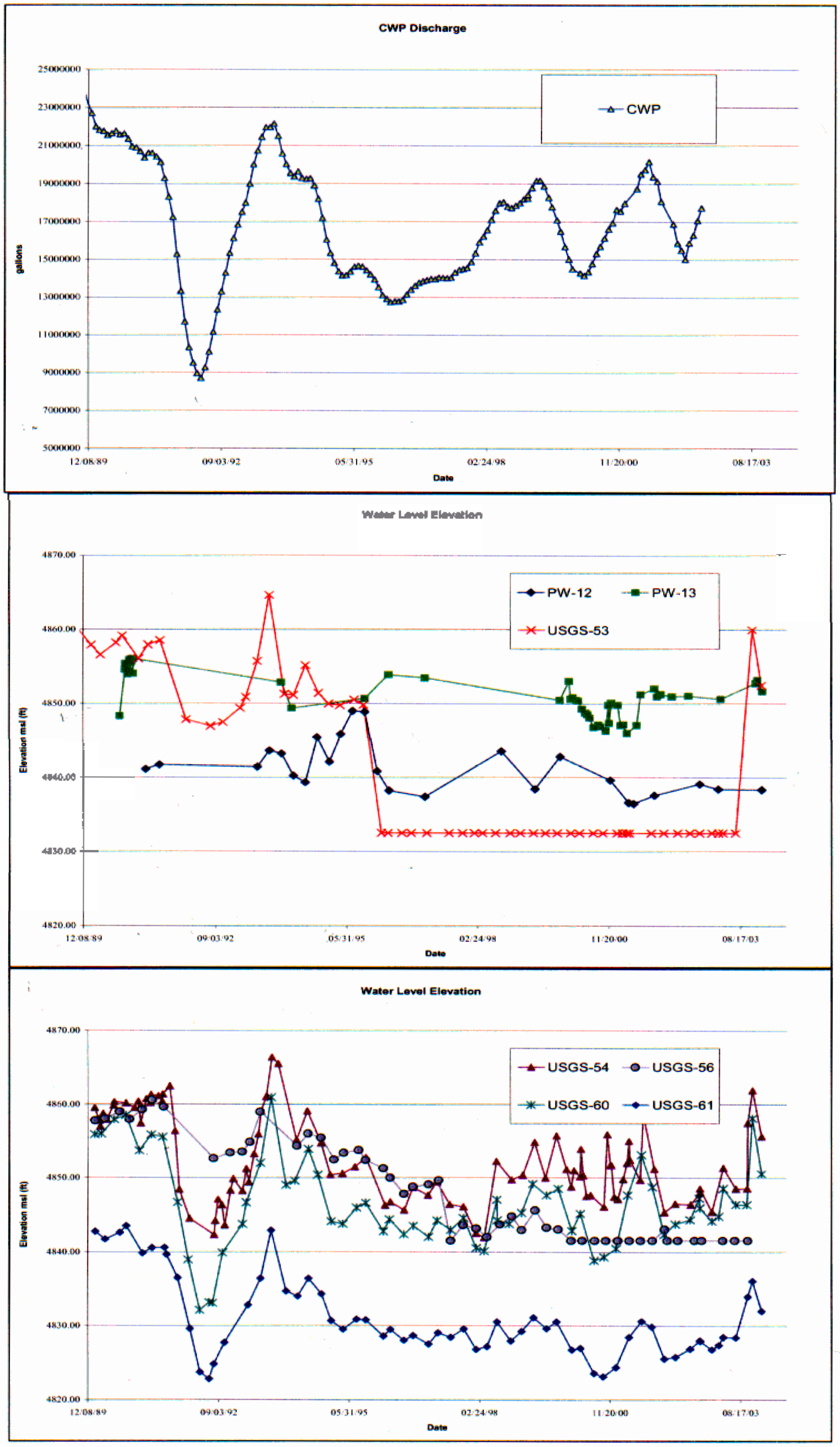

Figure 2. Cold Waste Pond discharge and hydrographs of Test Reactor Area perched water wells.

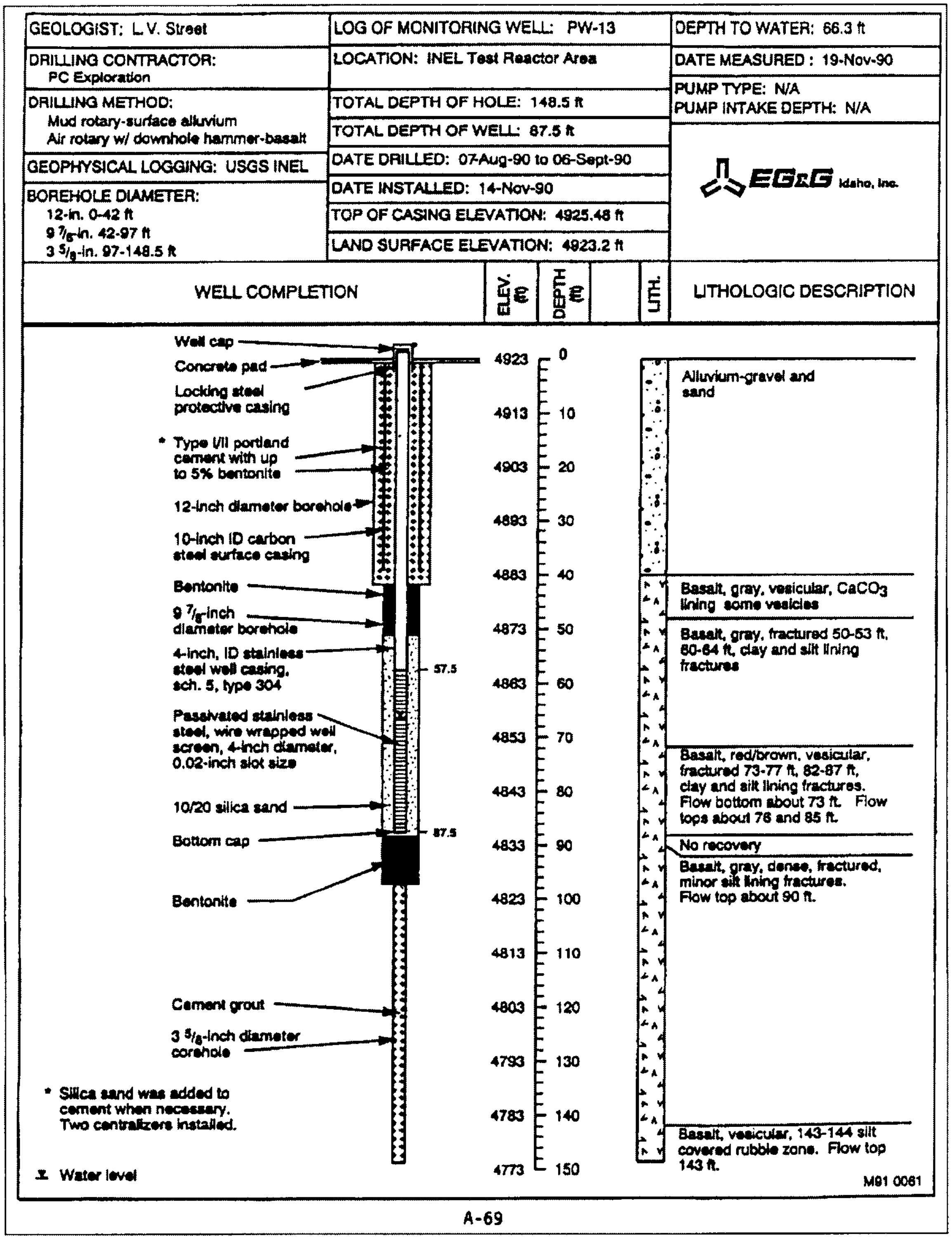

Figure 3. Well completion diagram and lithology at PW-13.

2.3.2 History of Diesel Contamination in PW-13

A diesel odor was noted during the coring of well PW-13 on September 6, 1990. The core rods were removed, and product samples were collected for analysis. A video log of the corehole showed a diesel thickness of approximately 8.5 ft of free-phase diesel above the diesel water interface at 75.5 ft (4,847.82 ft msl). The video log also showed what may have been diesel entering the corehole at 47 ft bls. Over the next 6 weeks, the thickness of the diesel in the corehole was measured and the free-phase diesel was removed by bailing. Approximately 20 gal of diesel were removed between September 7 and November 9, 1990. The volume of diesel recovery in the corehole progressively decreased to a trace amount or thin film. When well construction was initiated on November 14, no diesel was noted in the corehole. Diesel was not noted during well development on January 9, 1991.

Six measurements were made between December 1990 and April 1997; all the measurements indicated no free product within the well. No new measurements were made until November 1999 when a 1.03-ft layer of diesel was measured. Diesel thickness increased to 1.37 ft in February 2000 and then began decreasing until no free product could be measured in August 2000. A thickness of 0.11 ft was measured in September 2000, but no diesel was found in November 2000. Free product was not measured in the well until November 1999, when a diesel thickness of 1.03 ft was measured. The diesel subsequently decreased to a nondetectable level and then returned twice since 1999. Measurements made since June 2001 have indicated a continued presence of diesel. Recent measurements made during this investigation have recorded diesel thicknesses of 3.3 ft and 1.2 ft in December 2003. Figure 4 shows the history of measured diesel thicknesses in PW-13.

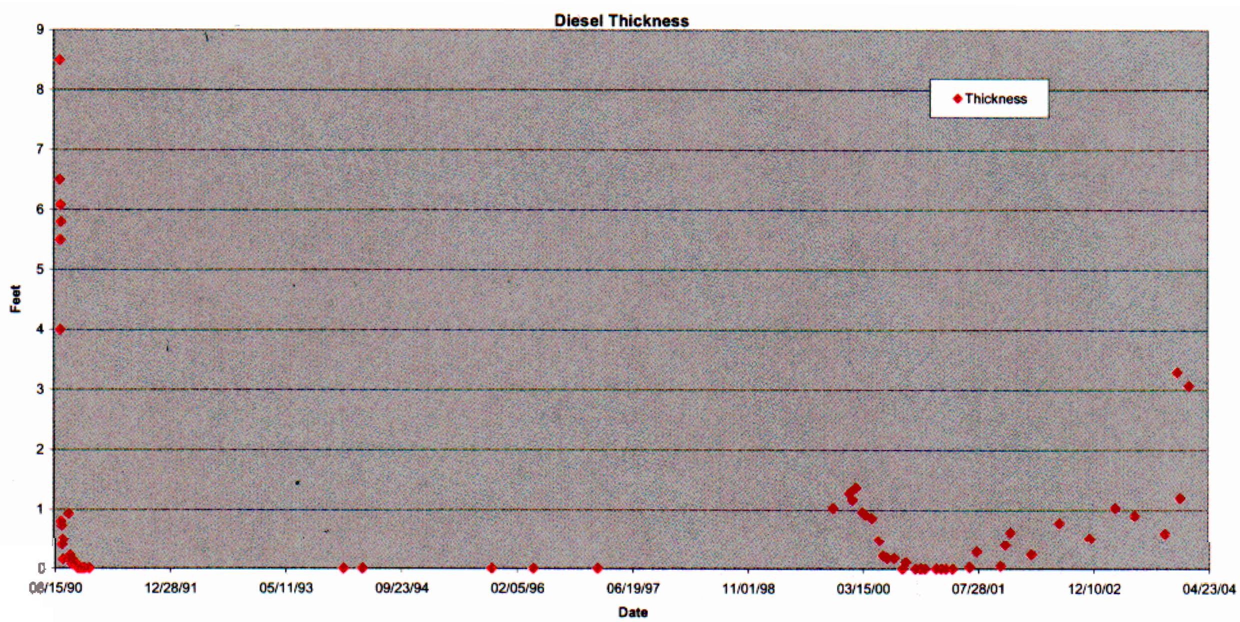

Figure 4. Diesel thickness in PW-13.

The initial samples of PW-13 prior to completion of the well indicated that the product was diesel fuel. Sampled free product density was measured at 0.84 g/ml, which is near the diesel density value of 0.827 g/ml. The increased density likely reflects the decay of gasoline range aliphatic and cycloalkane hydrocarbons.

Initial samples collected from PW-13 in 1990 did not contain the aromatic hydrocarbon compounds benzene, ethylbenzene, or toluene, common trace constituents of diesel. Xylene, another common trace constituent of diesel was found at a level of 31,000 ug/L during the 1990 sampling. The high xylene concentration appears to be anomalous when compared to the benzene, ethylbenzene, and toluene concentrations obtained in 1990, as well as subsequent data collections in 2001. The anomalous concentration of xylene may be the result of a laboratory error. Subsequent sampling indicated xylene concentrations were below detection limits until June 2001, when one of four samples collected contained 2 ug/L. Ethylbenzene was found at a concentration of 5.41 ug/L in 1993. Concentrations of ethylbenzene were below detection limits by 2001. Benzene has only been detected once in PW-13; in 2001, a concentration of 0.6 ug/L was estimated from analytical results.

Sampling of PW-13 is infrequent as it is not part of the TRA groundwater monitoring network. Sampling conducted after 1990 was limited, and data results showed high levels of diesel range organics (DRO) and gasoline range organics (GRO). Samples collected in May 2001 contained high concentrations of DRO (EPA Method 8015B) and GRO (EPA Method 8015B) at concentrations of 72,000 ug/L and 43,000 ug/L, respectively. The well was most recently sampled in June 2001. Samples collected during this sampling event contained similarly high levels of DRO (7,300–83,000 ug/L) and GRO (10–21,000 ug/L). Samples for DRO and GRO were collected in May and June 2001, and no clear conclusion can be determined as to an overall increase or decrease of the concentration of the contamination.

The absence or low concentrations of BTEX compounds and the higher density may indicate that the diesel has degraded.

2.3.3 Probable Source of Free-Phase Diesel in PW-13

A review of historical documents and available information point to the diesel transfer line (TRA-57) that ran from TRA-727 and TRA-775 to ETR as the source of diesel in PW-13. The fuel line was installed in the late 1950s and was abandoned in the early 1980s. Two leaks which occurred in 1980 and 1981 are documented for this transfer line in the *Preliminary Scoping Track 2 Summary Report for the Test Reactor Area Operable Unit 2-04: Fuel Spills* (Sherwood et al. 1994). The 1981 diesel spill is also documented in *Track 1 Sites: Guidance for Assessing Low Probability Hazard Sites at the INEEL, Site Description: Abandoned Buried Diesel Fuel Line from TRA-727 and TRA-775 to ETR, Site ID: TRA-57*, *Operable Unit 2-14* (INEEL 2002). This latter report provides information that was not included in the above-mentioned *Preliminary Scoping Track 2 Summary Report* (Sherwood et al. 1994). References for the above leaks have some conflicting information concerning the dates for both leaks, as well as resolution of the earlier leak.

The 1980 leak may have been noted due to discrepancies between utilities usage and storage tank volumes (Sherwood et al 1994). The leak was noted as having been fixed, but the discrepancies may have been caused by an operational change in the output of the generator rather than by a leak. The *Environmental Characterization Report for the Test Reactor Area* (Doornbos et al. 1991) stated that the line was replaced from TRA-605 to the turn between MTR and ETR. No estimation of volume or information concerning removal or discovery of contaminated soil around the reported excavation could be located.

The 1981 leak occurred at an elbow in the fuel transfer line 60 ft northeast of PW-13 (see Figures 1 and 9). The leak was discovered when the day tank supplying the ETR generator would not fill while the transfer pumps were operating at full capacity. A volume of 2,000 gal was estimated to have been released based upon pumping rates, the elapsed time, and the capacity of the transfer pipe (Sherwood et al. 1994). The day tank was excavated and inspected, and found not to have leaked. The transfer line was repaired by splicing the fuel line into a nearby abandoned steam line. In December 1990, a Tracer Tight test was conducted on the fuel line (INEEL 2002). The test did not reveal any leaks in the reconfigured fuel line.

Two diesel tanks were associated with the TRA-57 diesel line. Both were removed in the early 1990s. Neither tank showed signs of leakage, although the ETR tank did have some contaminated soil removed from the excavation (INEEL 1993a, 1993b). It is unlikely that these tanks contributed to the source of diesel detected in well PW-13

Further research did not reveal another possible point of origin for the diesel. Utility maps do not show any other nearby transfer lines, and the only fuel tanks in the area were removed. Fuel tanks currently in use are at the north end of the facility, over 1,800 ft north of PW-13. No spills of significant quantities were reported in the area of PW-13.

2.4 Conceptual Model of Recurrence of Diesel

A review of historical data from PW-13 did not suggest a new or ongoing source for the diesel. There are currently no sources of diesel within 1,800 ft of PW-13. The organic chemistry data collected at PW-13 indicated degraded diesel with very low to no detectable BTEX. BTEX compounds are lighter organic compounds and are generally the first to degrade. The data support the concept that the continued recurrence of diesel in the well most likely results from the 1981 leak in the diesel fuel line.

A review of the field team leader logbook noted possible diesel entering the corehole at approximately 47 ft bls during the video log. A recent review of the PW-13 video log confirmed that fluid was entering the corehole at approximately 47 ft bls (4,876.32 ft msl), but the fluid could not be conclusively identified as diesel. This apparent flow of diesel could be the cause of the initial accumulation of approximately 8.5 ft of diesel in the borehole. Although no diesel contamination was observed in the core, the corehole could have been placed near an accumulation of migrating diesel. The diesel could have continued to migrate toward the corehole during continued coring and then entered the corehole on about September 5, 1990. After the diesel was removed and the well constructed, the diesel may have migrated downward through the vadose zone until encountering perched water, perhaps around 1999. Upon reaching the perched water, the diesel would have spread laterally into PW-13. The lack of diesel contamination during drilling, the observations in the video log, and the 9-year gap between the initial discovery of diesel and the subsequent recurrence of diesel support this theory.

In an idealized homogeneous system it would be expected that the thickness of floating diesel would build to its maximum thickness and slowly thin as the diesel was attenuated by natural processes of advection, diffusion, and degradation. This idealized scenario is not observed at PW-13, probably as a result of heterogeneous, isotropic, and transient conditions of the subsurface environment. Although the exact reason for the nonideal behavior of the diesel may never be known, it is important to outline several possible mechanisms that might cause the observed behavior. Several mechanisms have been identified as potential causes for the recurrence: scavenging, residual diesel saturation, interconnected fractures, fracture traps, transient condition due to changing flow paths/changes in discharge to the CWP, or continued diesel flux due to precipitation/leaking water pipes. Possibly the recurrence is a combination of two or more of these mechanisms. The suggested mechanisms are discussed in the following sections.

2.4.1 Remobilization and Fracture Trapping

The recurrence of diesel seems to have some correlation to the water level elevation in the well. Figures 5 and 6 show all the recorded diesel thicknesses and water level measurements. A highly vesicular, fractured basalt zone exists between 72.5 and 78 ft bls (4,850.82 to 4,835.32 ft msl). Diesel accumulation in the well has occurred in two zones of vesiculation. One recurrence of diesel was noted at approximately 76.5 ft bls (4,846.82 ft msl). The lithology at this depth is vesicular and fractured, and is also the location of a basalt flow top and bottom. The second interval of recurrence is above 72.5 ft bls (4,850.82 ft msl). This interval is also vesicular and fractured with a flow top noted at approximately 73 ft bls (4,850.32 ft msl). It is possible that as the water level rises in the well, diesel trapped in the fractured, vesicular zones may be remobilized (floated) (Figure 7). Diesel may continue to accumulate as the water level rises until the water level reaches a more competent, less vesicular basalt above the vesicular zones. The diesel in the corehole may slowly exit through the decreased number of fractures in the more dense section along the top of the perched water in the direction of the local hydraulic gradient. As the water level decreases, the diesel may flow more rapidly into the vesicular, fractured zone beneath 73 ft bls (4,850.32 ft msl).

Diesel that flowed out of the well into the dense, slightly fractured zone may migrate down vertical fractures into the vesicular zone. Diesel that flowed back into the highly fractured, vesicular zone may also return to fracture traps and vesicles. In this scenario, some diesel will remain in the well as the water level decreases below the fracture zone. The diesel may migrate along the top of the perched water zone in the direction of decreasing hydraulic gradient and out of the well. The diesel contained in fracture traps and vesicles would remain in place until being remobilized again by rising water levels. The diesel could potentially be recycled repeatedly with only slight decreases in the overall volumes detected.

2.4.2 Changing Flow Paths

Changing flow paths in the perched water may also influence the diesel recurrence. The highly variable discharge to the CWP may alter the local hydraulic gradient during minimum or maximum discharge events. During higher discharge to the CWP, a secondary flow path may be used, causing a remobilization of pockets of diesel unaffected during lower discharge. Decreasing flow will cause this secondary flow path to become inactive until flow discharge increases. Flow paths could also be altered by precipitation, but no strong correlation to the diesel recurrence can be made during wet years. An alteration of a flow path or a new flow path could also be created by leaking water pipes. Water lines for the fire system and potable water lines pass within 60 ft of PW-13. Preliminary review of the water chemistry in PW-13 shows water chemistry similar to the Snake River Plain Aquifer (SRPA) or infiltration rather than to water found near the CWP.

2.4.3 Interconnected Fracture System

An interconnected fracture system will function in a similar manner to the fracture trapping mechanism. A system of connected fractures containing diesel could act as reservoirs. Changes in the water level could allow the diesel in the fracture to flow to the well, migrating vertically and horizontally along a connected fracture system (Figure 8). The free diesel migrating away from the well could collect in the same or different fracture systems depending on the flow conditions, and reenter PW-13 during another change in water.

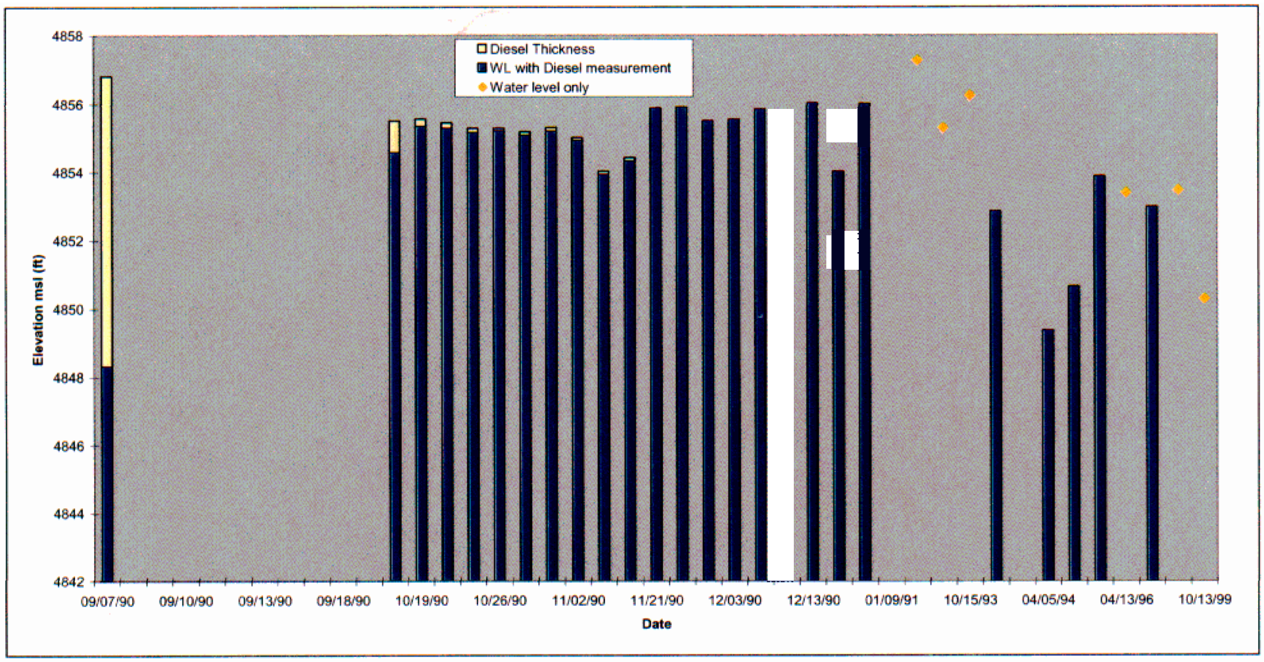

Figure 5. Diesel thickness and water level in PW-13 (1990–1999).

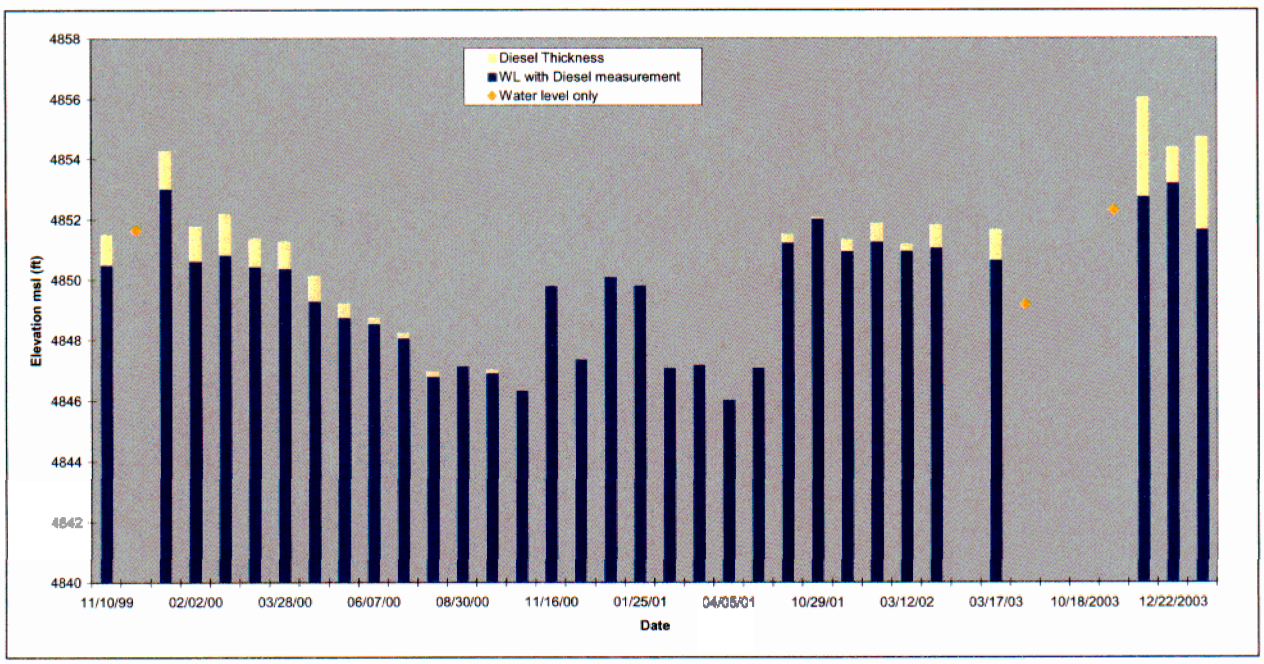

Figure 6. Water level and diesel elevation in PW-13 (1999–2003).

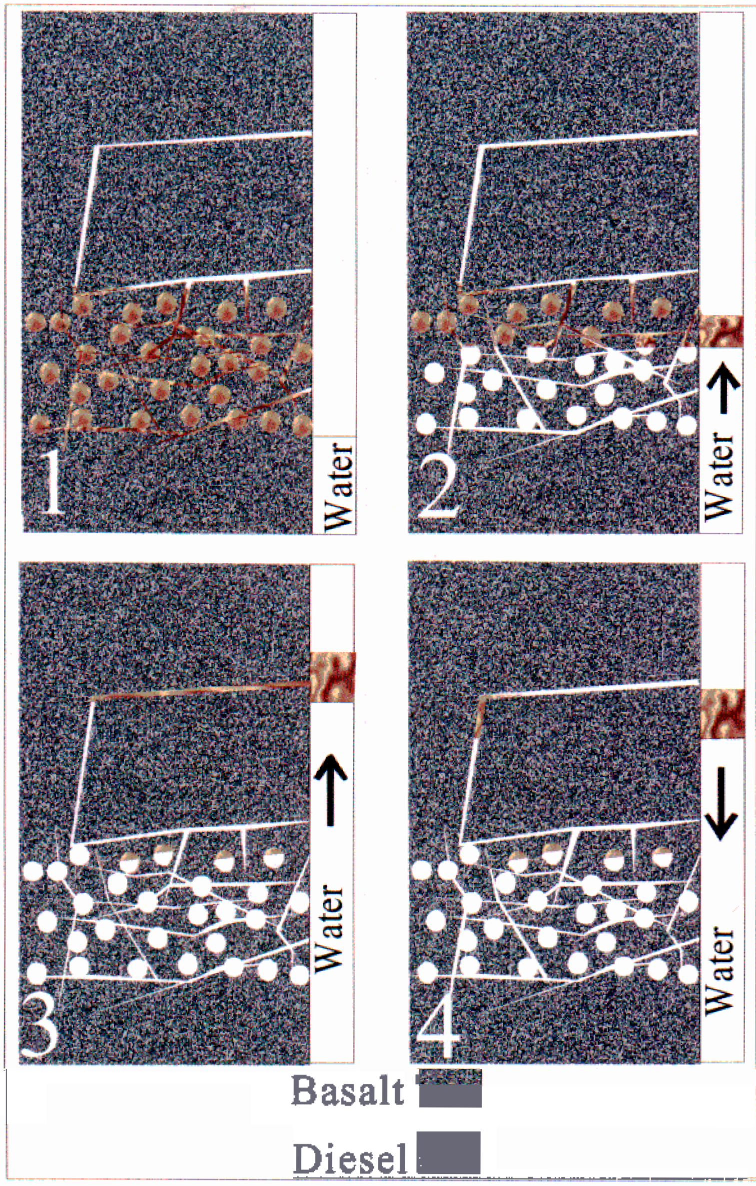

Figure 7. Illustration of remobilization and fracture trapping during rising and falling water levels.

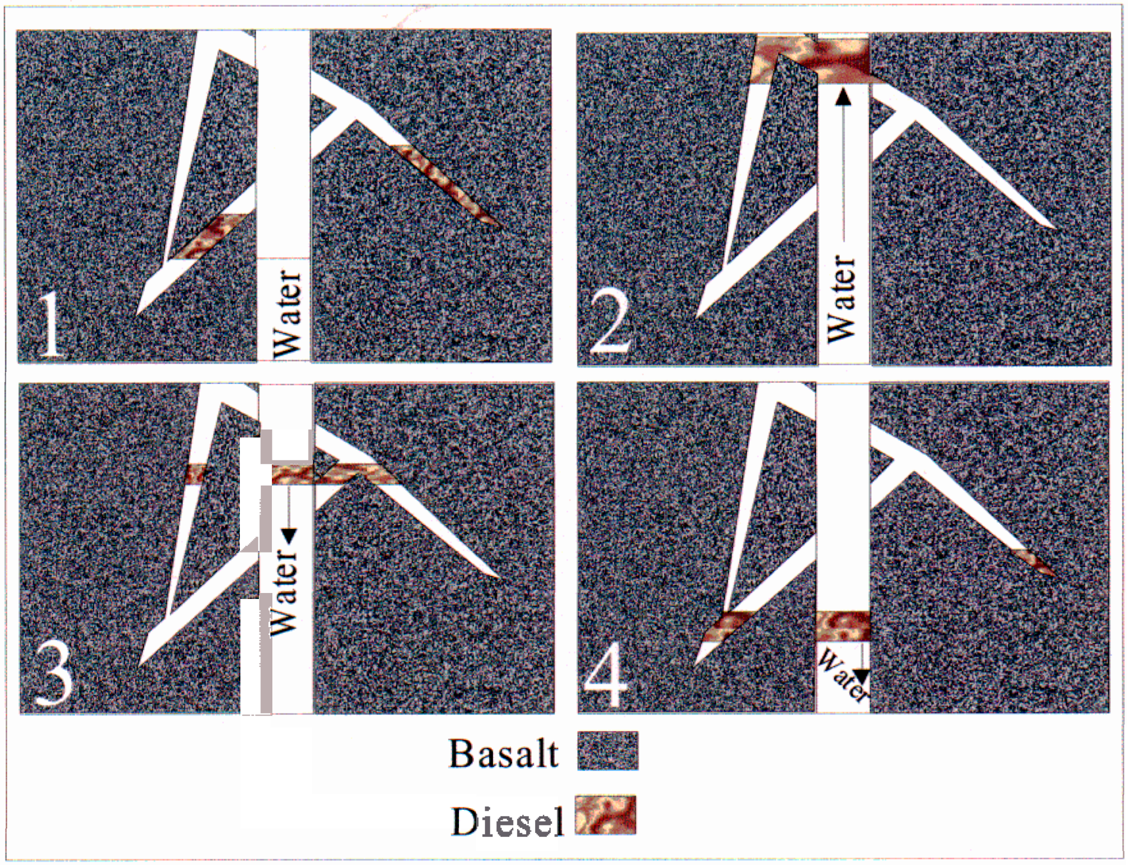

Figure 8. Illustration of a simple interconnected fracture system and diesel movement during changes in water level.

2.4.4 Continued Diesel Flux

A continued flux of diesel from the vadose zone could be caused by slow migration of the diesel, or the diesel could be driven by precipitation or leaking water lines. A review of the precipitation records does show a slight influence on the water level in PW-13 during wet years, but does not correlate to the individual diesel recurrences. No leaks within the water system at TRA are currently documented. A continued, slow migration of diesel from the area of the original source does not seem likely. A continued slow migration of diesel would likely cause a slow, steady accumulation of diesel, with a continuous presence in the well rather than an episodic recurrence of the diesel.

2.4.5 Pulsed Flux of Diesel from Fractures

Alternatively, diesel fuel that leaked from buried distribution systems in the early 1980s may have pooled at the contact between the alluvium and basalt. The pooled diesel may then have migrated into cooling fracture sets and interconnected vesicules that typically are present in the upper parts of basalt flows on the eastern Snake River Plain. Few fractures extend vertically through the massive flow centers. Because these fracture sets are not well connected vertically, they may have acted as reservoirs for the diesel. Construction of the corehole in 1990 may have intersected one of these diesel-filled fractures, allowing drainage to the borehole and pooling at the perched water level when drilling operations ceased overnight.

After completion of the well, transient conditions in the shallow subsurface, including short-term fluxes from the CWP, discontinuation of the WWP, local precipitation, and other sources of recharge, periodically could have displaced some remaining diesel in the fractures, moving it into a set of fractures intercepted by well PW-13. This pulse of diesel would then have formed a layer on the water surface. The layer would then thin as diesel moved out through the wellscreen from the well into the more permeable sections of basalt.

3. OBJECTIVES AND WORK SCOPE

3.1 Objectives

The objectives of this project are to evaluate the following:

- The sources of perched water using general groundwater chemistry (major anions and cations), and to evaluate the natural remediation potential of perched water.
- Define the lateral extent of free-phase diesel or dissolved constituents in the vicinity of PW-13.
- Install two monitoring wells to provide monitoring points.

The results of this investigation will be summarized in a technical report. The activities performed during the investigation should provide information to define the zone of free-phase diesel. The collected data may also identify the mechanism controlling the continued recurrence of free-phase diesel in PW-13.

3.2 Plan Preparation

3.2.1 Health and Safety Plan

In accordance with requirements presented in the "Occupational Safety and Health Administration Standards" (29 Code of Federal Regulations (CFR) 1910) and "Hazardous Waste Operations and Emergency Response" (HAZWOPER) (29 CFR 1926.65), a site-specific health and safety plan (HASP) will be developed for this project. This HASP will govern the execution of all fieldwork performed by INEEL employees, subcontractors to the INEEL, and employees of the Department of Energy Idaho Operations Office. Personnel not normally assigned to perform work at this Site, such as representatives from the State of Idaho, the Occupational Safety and Health Administration, and the U.S. Environmental Protection Agency are considered nonworkers who meet the definition of occasional Site workers as stated in 29 CFR 1910.120 and 1926.65.

The HASP (pending) will be reviewed and revised as necessary by the Long Term Stewardship Health and Safety Officer and other appropriate representatives from Environmental, Engineering, Quality Assurance, and the project management team to ensure the suitability and appropriateness of the HASP. Following approval and signature, the HASP will be reviewed and signed by all members of the project team performing work at the site.

3.2.2 Environmental Checklist

In accordance with company requirements for the performance of work at the INEEL, and to meet National Environmental Policy Act (42 USC § 4321 et seq) requirements, project management will complete an environmental checklist to identify potential physical and environmental hazards associated with the execution of this work. The environmental checklist provides a systematic approach to identify associated hazards, and directs project personnel to various requirements and procedures that must be followed to ensure that the work is completed in a manner that is protective of human health and safety, and the environment. Depending on the activities identified as part of the project, appropriate individuals from a variety of work disciplines will review and approve this document. Requirements identified in this document, which are necessary to perform the work in a safe and environmentally conscientious manner will be incorporated into the work control documents for this project.

3.2.3 Field Sampling Plan

A field sampling plan (FSP) will be developed as a stand-alone document and will contain sampling objectives, sample locations and frequency, sample designations, sampling equipment, and sample handling and analysis associated with the execution of this work.

A quality assurance project plan will be prepared which will include procedures designed to ensure sample integrity, precision, and accuracy in the analytical results, and that the environmental data collected will be representative and complete.

3.3 Field Activities

Field activities to be performed under this Characterization Plan include drilling and sampling. These activities will be performed in conjunction with each other, but each activity will be explained separately. Sampling will be conducted for selected organics (hydrocarbon constituents), inorganics, and radiological constituents.

3.3.1 Drilling

Investigation of the subsurface will be conducted to constrain the extent of diesel contamination and to potentially provide information as to the mechanism controlling the continued recurrence of diesel in PW-13. It is anticipated that diesel contamination will be encountered during drilling. Two boreholes will be drilled using a dual rotary drilling system equipped with a 6-in. nominal bit and 7 5/8-in. casing. The 6-in. bit and the 7 5/8-in. casing will be advanced to the basalt simultaneously. The 6-in. bit will continue to total depth with the 7 5/8-in. casing remaining in place from ground surface to the alluvial/basalt interface until completion of the well. Drilling will be conducted with water injection to prevent subsurface difficulties. During drilling, an onsite geologist will log lithology, drilling conditions, and any observed diesel contamination. The geologist will keep a chip tray with collections occurring no less often than every 5 ft and every change in lithology.

Drilling will be conducted on a closed road near subsurface utilities. A subsurface utilities survey will be conducted to determine the exact location of all utilities within the selected drilling areas. Boreholes will be drilled at least 5 ft from underground utilities without special authorization, and 50 ft or more from any overhead utilities. Utilities in the drilling areas include power, water, acid, diesel, hot drain lines, and cold waste transfer pipes. Many of these utilities are no longer in service. Figure 9 shows the proposed well locations and the site of the 1981 diesel release.

The boreholes will be advanced 15 to 20 ft into the perched water; the current water level is approximately 73 ft bls. When total depth is achieved, the drill rods and bit will be removed from the borehole, and the water level and diesel thickness will be measured. After the measurements are completed, the wells will be constructed using 2-in., Schedule 40 polyvinyl chloride (PVC) (0.02-in. slot) and a filter pack of 10/20 silica sand. The slot size and filter pack will be the same as was used in PW-13

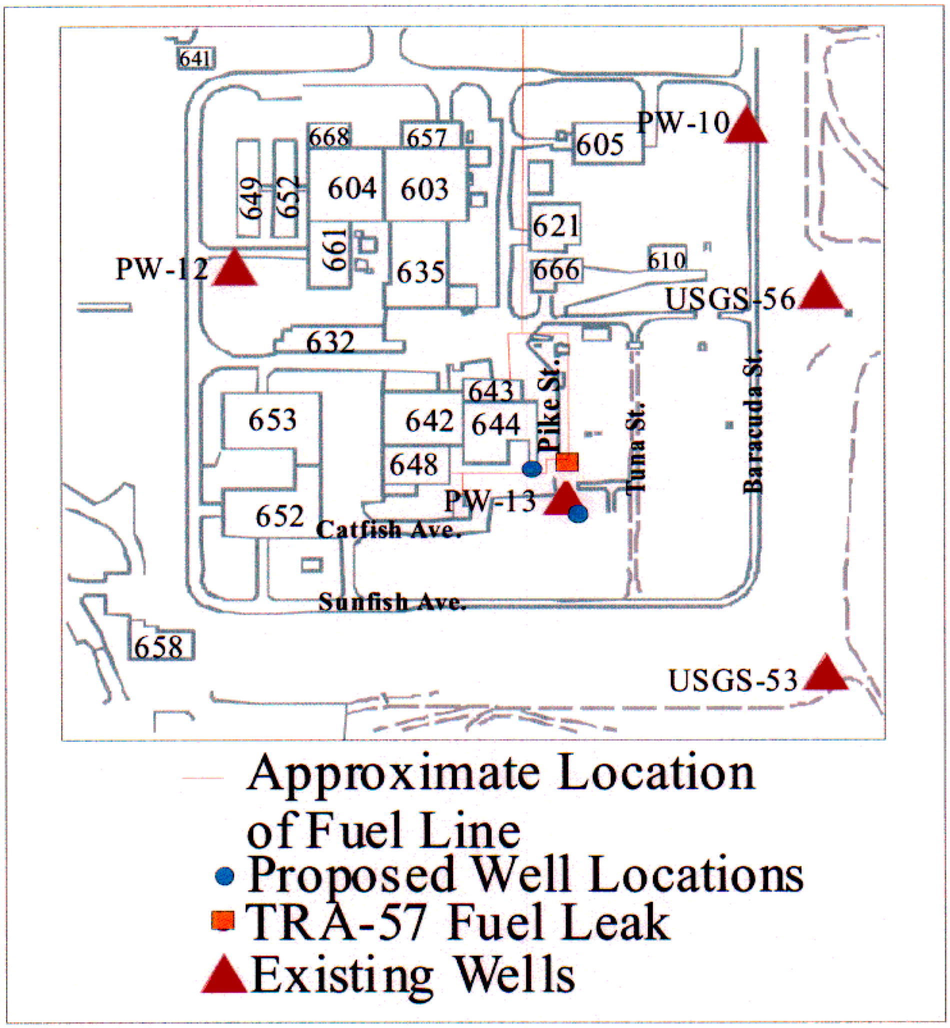

Figure 9. Proposed well locations at TRA for the PW-13 diesel investigation.

for more accurate comparisons. The wells will be constructed with a 30-ft screen, and about 10 ft of the screen will be placed above the current water table. The screen will be placed across the current water table level due to substantial variation in the perched water level. A bentonitie seal will be installed from the top of the sand pack to ground surface to prevent contamination from migrating down the borehole. Grout may be used in conjunction or in place of the bentonite. It is anticipated that the screened interval will be approximately 63 to 93 ft bls (4,860.32 to 4,830.32 ft msl). The placement of the screen above the water table will allow free-phase diesel floating above the water table to enter the well. Wells will be purged a minimum of 5 borehole volumes, or until water parameters stabilize so that a perched water sample can be collected that is unaffected by drilling.

Cuttings and water generated during drilling in the perched water will be contained in a Frac Tank or similar style tank with secondary containment until Waste Generator Services (WGS) determines a proper disposal for the waste. All waste generated during the project will be disposed of under the direction of WGS.

3.3.1.1 Water Levels and Diesel Thickness Measurements. If diesel is encountered during the drilling of a well, measurements of the thickness of the diesel and the water level will be made prior to sampling.

3.3.1.2 Groundwater Sampling. Upon completion of the development of each well, water samples will be collected. Each well will be sampled for BTEX, DRO, GRO, alkalinity, anions, unfiltered chrome, filtered metals, gamma spec, and tritium (Table 1). Filtered chrome concentrations will be included in the filtered metals. Samples will be collected in accordance with the FSP (pending). During sampling, the field team will collect and record the pH, conductivity, temperature, and dissolved oxygen measurements of the water.

Groundwater sampling for the existing wells will be conducted in conjunction with quarterly groundwater monitoring for TRA. Sampling will be conducted through a Document Action Request (DAR) of the *Groundwater Monitoring Plan for the Test Reactor Area Operable Unit 2-13* (DOE-ID 2003b). The wells to be drilled as part of this Characterization Plan will be sampled under a field sampling plan (FSP) generated specifically for this project (pending). Sampling efforts for the existing wells and the proposed wells are described in the following sections.

3.3.1.3 Organics. Analytical data for organic constituents in PW-13 have not been collected since June 2001. Selected perched water and aquifer wells will be sampled for diesel range organics (DRO) (Table 1). Well PW-13 will be sampled for BTEX, DRO, and gasoline range organics (GRO). The sampling will determine the extent, if any, of the diesel migration in the perched water, and will determine whether diesel has infiltrated to the aquifer. A comparison of the organic data results and the inorganic results may provide insight into the flow paths and migration of the diesel.

Table 1. Selected wells and their analyses.

Well	Alkalinity	Metals[a]	Anions	Cr	Gamma	Tritium	Sr-90	DRO	GRO	BTEX
TRA-1933[b]	X	X	X	X	X	X	X	X	X	X
TRA-1934[b]	X	X	X	X	X	X	X	X	X	X
CWP-1	X	X	X	X	X	X	X			
CWP-2	X	X	X	X	X	X	X			
CWP-3	X	X	X	X	X	X	X			
CWP-4	X	X	X	X	X	X	X			
CWP-5	X	X	X	X	X	X	X			
CWP-6	X	X	X	X	X	X	X			
CWP-7	X	X	X	X	X	X	X			
CWP-8	X	X	X	X	X	X	X			
CWP-9	X	X	X	X	X	X	X			
PW-8	X	X	X	X	X	X	X			
PW-7	X	X	X	X	X	X	X			
PW-9	X	X	X	X	X	X	X			
PW-10	X	X	X	X	X	X	X	X		
PW-11[c]	X	X	X							
PW-12[c]	X	X	X					X		
PW-13	X	X	X	X	X	X	X	X	X	X
PW-14[c]	X	X	X							

Table 1. (continued).

Well	Alkalinity	Metals[a]	Anions	Cr	Gamma	Tritium	Sr-90	DRO	GRO	BTEX
USGS-53[c]	X	X	X					X		
USGS-54[c]	X	X	X							
USGS-55[c]	X	X	X							
USGS-56[c]	X	X	X							
USGS-60	X	X	X	X	X	X	X			
USGS-61	X	X	X	X	X	X	X			
USGS-62	X	X	X	X	X	X	X			
USGS-63	X	X	X	X	X	X	X			
USGS-64	X	X	X	X	X	X	X			
USGS-66	X	X	X	X	X	X	X			
USGS-68	X	X	X	X	X	X	X			
USGS-69	X	X	X	X	X	X	X			
USGS-70	X	X	X	X	X	X	X			
USGS-71	X	X	X	X	X	X	X			
USGS-72	X	X	X	X	X	X	X			
USGS-73	X	X	X	X	X	X	X	X		
USGS-74	X	X	X	X	X	X	X			
USGS-75	X	X	X	X	X	X	X			
USGS-78	X	X	X	X	X	X	X			
TRA-03[d]	X	X	X							
TRA-07[c,d]	X	X	X					X		
TRA-08[c,d]	X	X	X							
USGS-58[c,d]	X	X	X							
USGS-76[c,d]	X	X	X					X		

a. Metals includes: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Si, Ag, Na, Sr, Tl, U, V, Zn.
b. Proposed wells to be drilled for this Characterization Plan.
c. Wells in the TRA monitoring network which are regularly sampled for Gamma Spectroscopy, tritium, and Cr.
d. Denotes aquifer well.

The organic sampling will determine the dissolved constituents in the groundwater. No free product or diesel odor has been noted in any of these wells, except PW-13. If odor or free product is noted, measurements of the diesel thickness will be collected with an interface probe.

3.3.1.4 Inorganics. The first five-year review for TRA OU 2-13 (DOE-ID 2003a) recommended decreasing the analyte list for the WAG 2 Groundwater Monitoring Plan (DOE-ID 2003b). The list was reduced to Co-60, Sr-90, Cr, and tritium. These contaminants are currently the only contaminants of concern, with concentrations either rising, or above, or recently above the maximum contaminant level. The presence of Cr, Sr-90, and tritium in the perched water are attributed to injection wells (TRA-D and USGS-53), disposal ponds, retention basins, and leaking pipes (DOE-ID 2003a). The perched water is routinely monitored by seven wells that provide appropriate monitoring of the perched water, but do not provide sufficient data to evaluate the dynamic subsurface flow. The most recent complete data set, including metals, anions, and radiological constituents for the majority of deep perched wells, was in 1991. A more recent data set needs to be assembled in order to determine the current disposition of perched water in all areas. Several perched water sources, present in 1991, are no longer in operation, decreasing the total volume and chemical mixture of the infiltrating water. The Chemical Waste Pond, the Warm Waste Pond, and the Sewage Leach Pond have all been removed from service since 1991. The elimination of infiltration from these sites has changed the chemical makeup and possibly the flow paths of the perched water system. By comparing the analytical data collected at the perched water wells to the chemistry of both known and potential sources of infiltrating water, the flow paths and the area of influence for each source may be identified.

The analyses needed to evaluate water and contaminant sources, and to update the vadose zone model are: filtered metals, anions (Cl^-, F^-, NO_3^-, SO_4^{3-}, nitrate/nitrite), alkalinity, unfiltered chrome, gamma spectroscopy, and tritium analysis for the perched wells. Sampling for metals and anion analysis will be conducted for selected aquifer wells. Wells to be sampled and their analyses are listed in Table 1.

The metal, anion, and radiological data will be used to (1) assist in the evaluation of the continued diesel presence in PW-13, (2) assist in the determination of the source of water for the Cr, Co-60, and tritium contaminations, (3) assist in the evaluation of possible sources of contamination, and (4) evaluate flux from the vadose zone into the aquifer.

3.4 Data Evaluation

The data and information obtained during these field activities will be appended to the existing data. Current ongoing projects which may obtain related or pertinent information will be reviewed, if possible. The evaluation will review all historical data as well as the new data and findings. The new round of inorganic sampling will be used to attempt to determine if flow paths are changing, causing the diesel to periodically reoccur. Data will be reviewed to determine source areas for the water in each well. The behavior of the diesel will be reviewed in relation to the chemistry, discharge volumes, and precipitation to attempt to determine the exact mechanism causing the recurrence and to constrain the area of contamination.

3.5 Summary and Conclusions

Following completion of the field activities and data evaluation, a summary report will be prepared. In addition to the activities detailed in this Characterization Plan, this report may include information and data generated from ongoing groundwater modeling of the perched water at TRA, as well as any other information from related ongoing projects.

4. SCHEDULE

Field work for the investigation is planned to begin in March 2004. The sampling not associated with the proposed well drilling, outlined in this Characterization Plan, will be conducted in conjunction with the quarterly TRA sampling scheduled in late March. Drilling is also planned to commence in March 2004. Drilling is anticipated to take one week.

The final technical summary report will be completed by the end of Fiscal Year 2004. Sampling results will require validation prior to reporting. Computer modeling of the TRA perched water is currently underway, but is not anticipated to be completed until mid-summer. The results of the modeling may be used in conjunction with the findings of this Characterization Plan, if time permits.

5. REFERENCES

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